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Ditzler

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(54) **BLADE APPARATUS WITH BLADE PITCH ADJUSTABILITY**

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E02F 3/76 (2006.01)

(52) **U.S. Cl.** **172/818**; 172/739; 172/826

(58) **Field of Classification Search** 172/739, 172/810, 811, 818, 826
See application file for complete search history.

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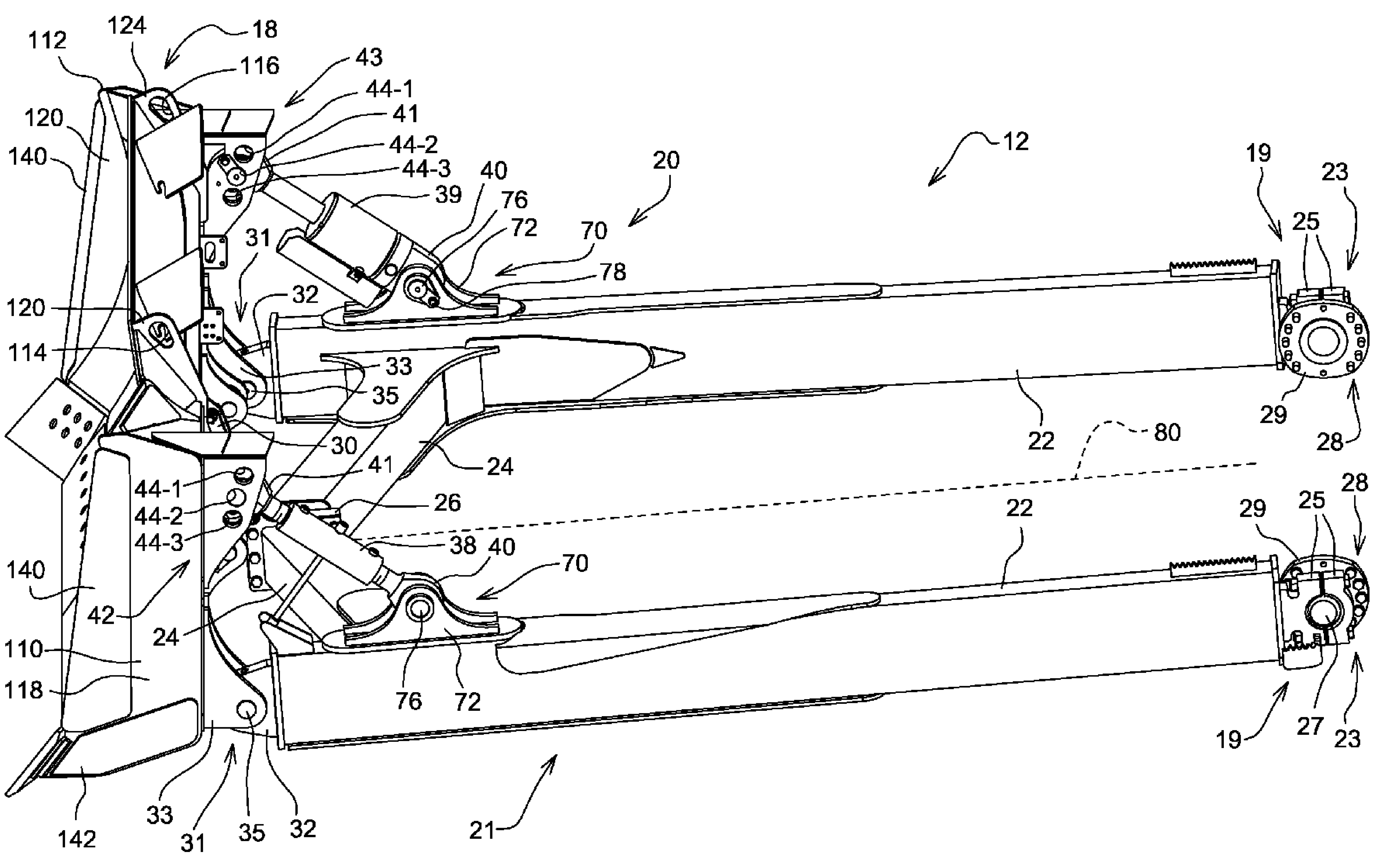
(57) **ABSTRACT**

A blade apparatus for a work vehicle comprises a blade and first and second link anchors mounted to the blade. Each link anchor comprises a plurality of mounting points for adjusting the pitch of the blade.

8 Claims, 11 Drawing Sheets



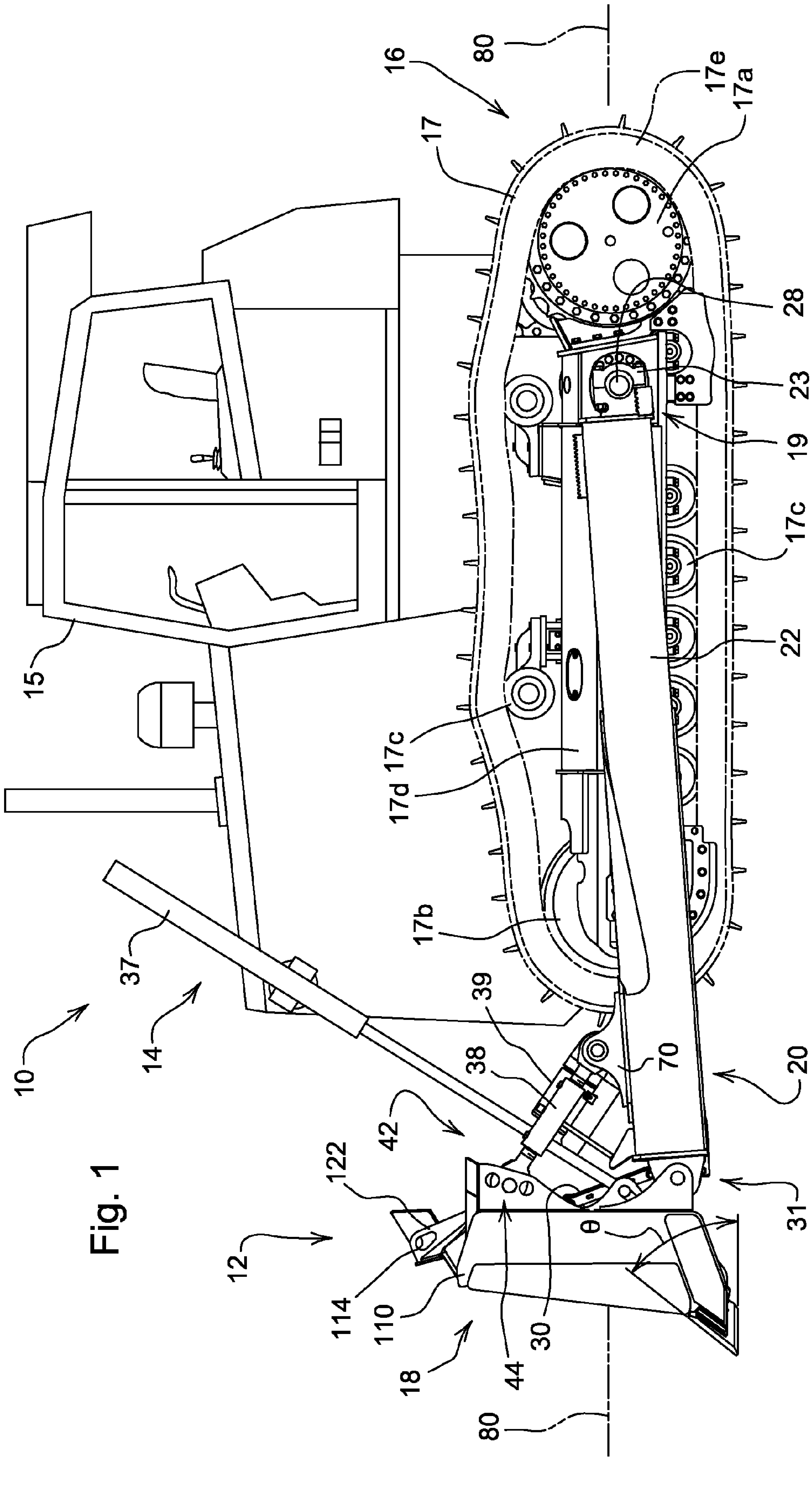

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Fig. 1

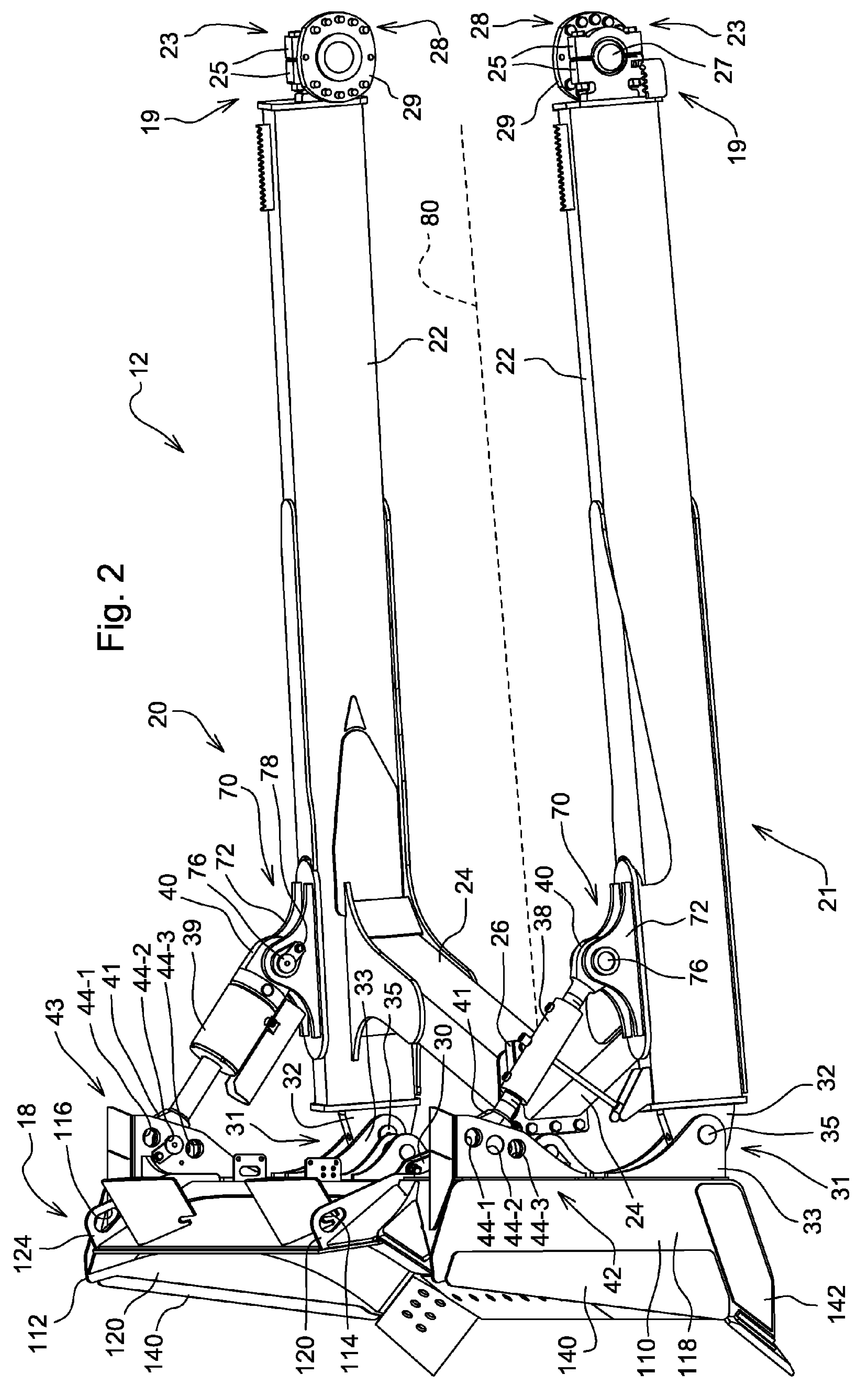
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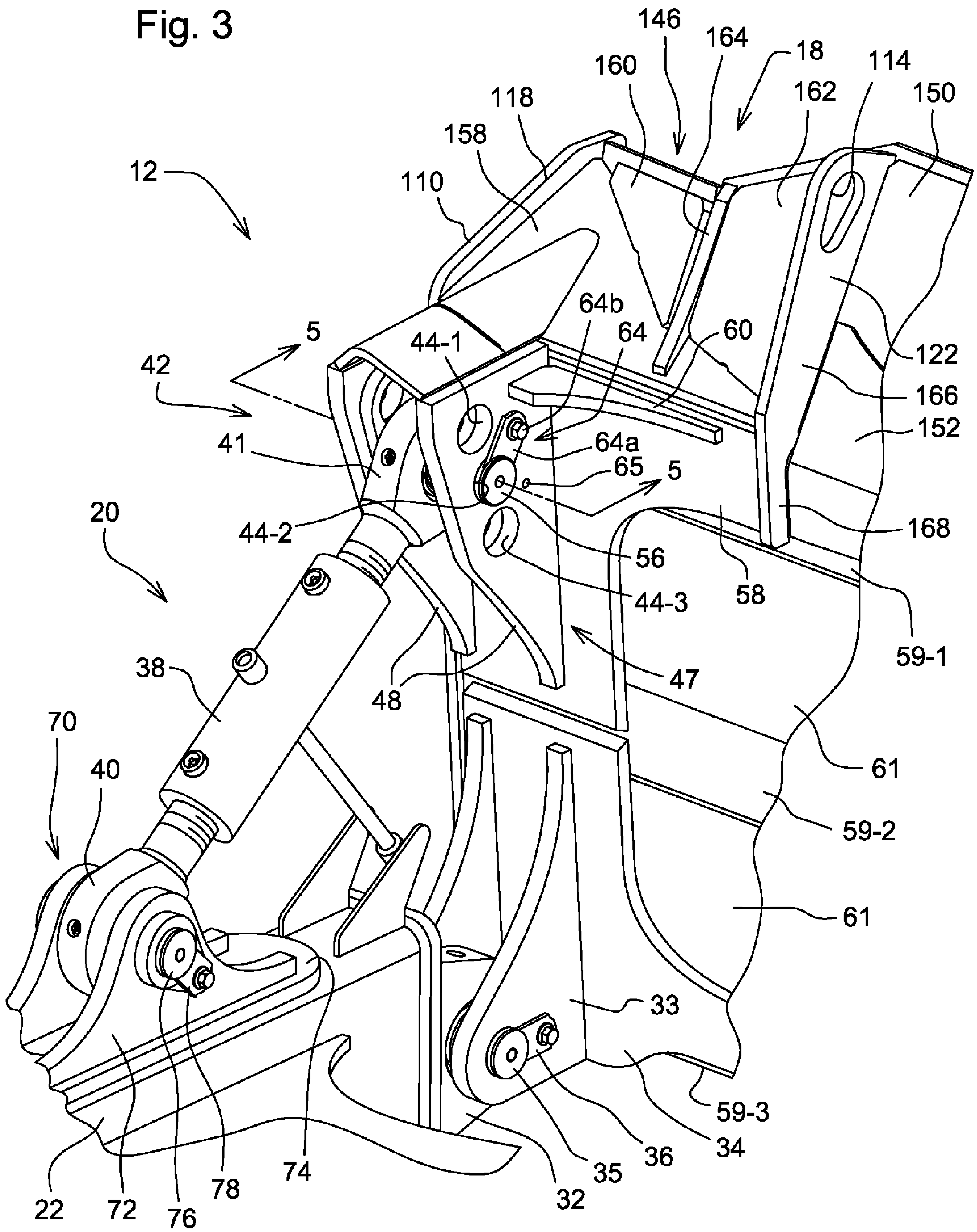
Fig. 2

Fig. 3



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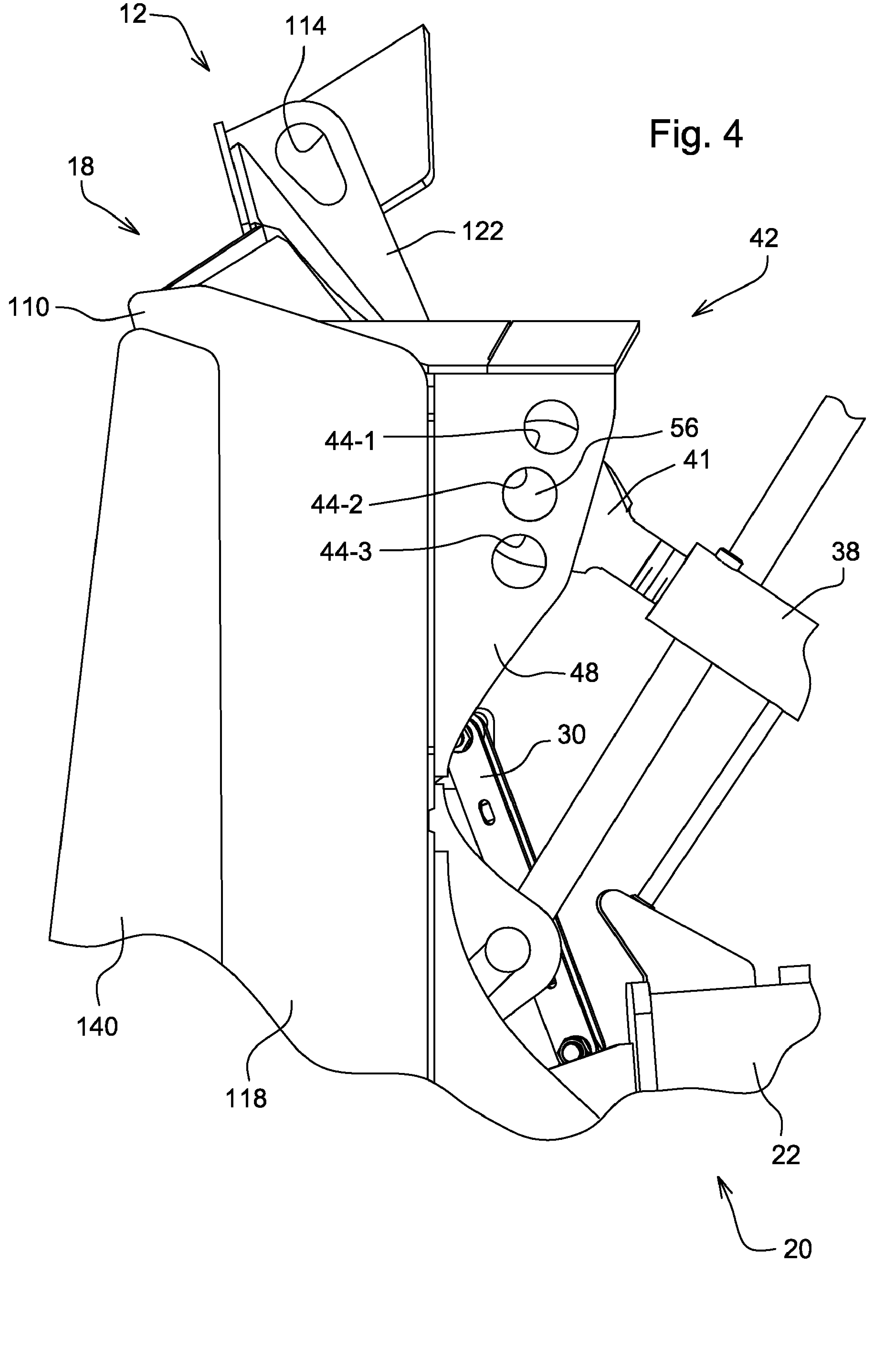
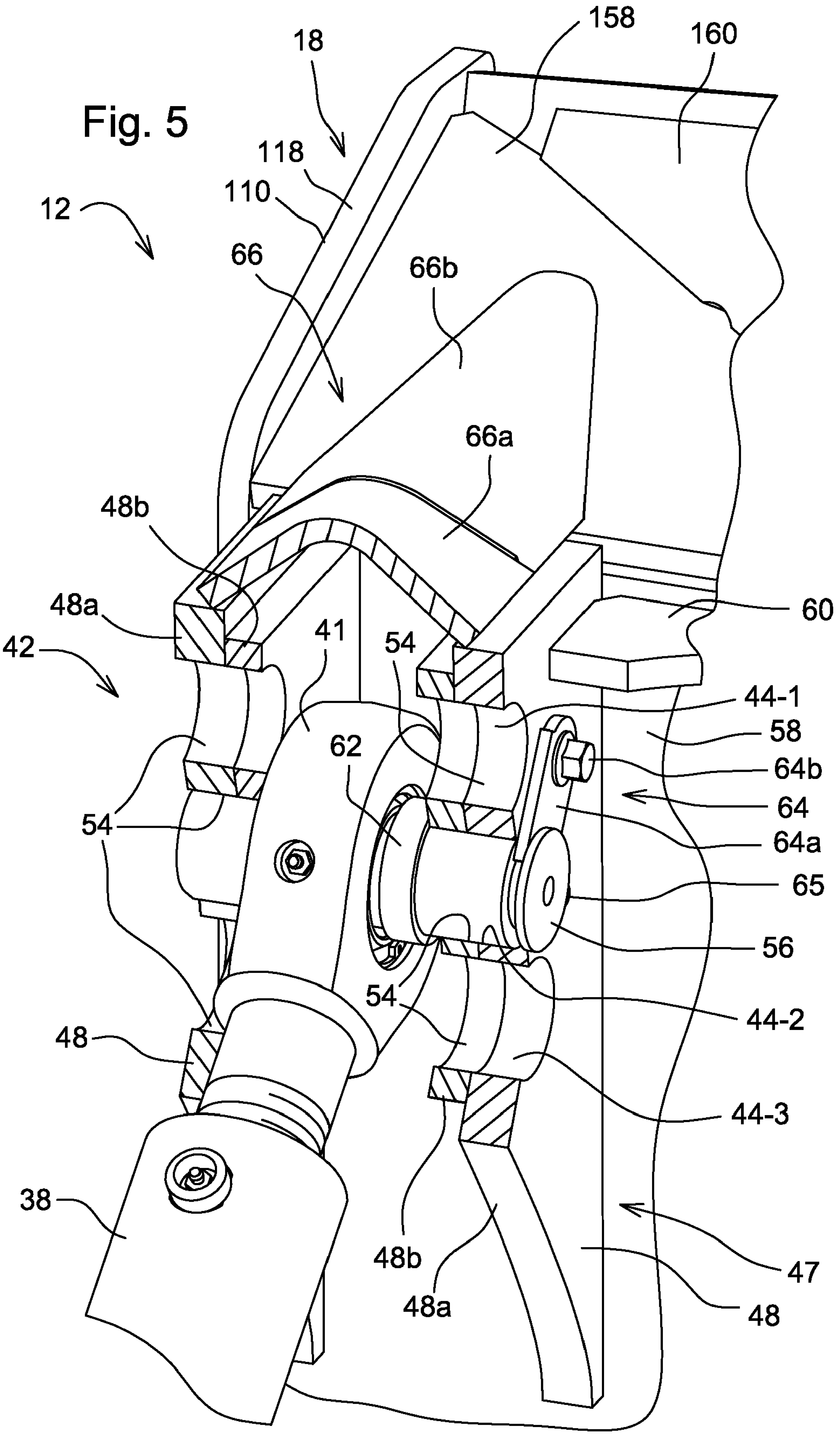


Fig. 4

Fig. 5



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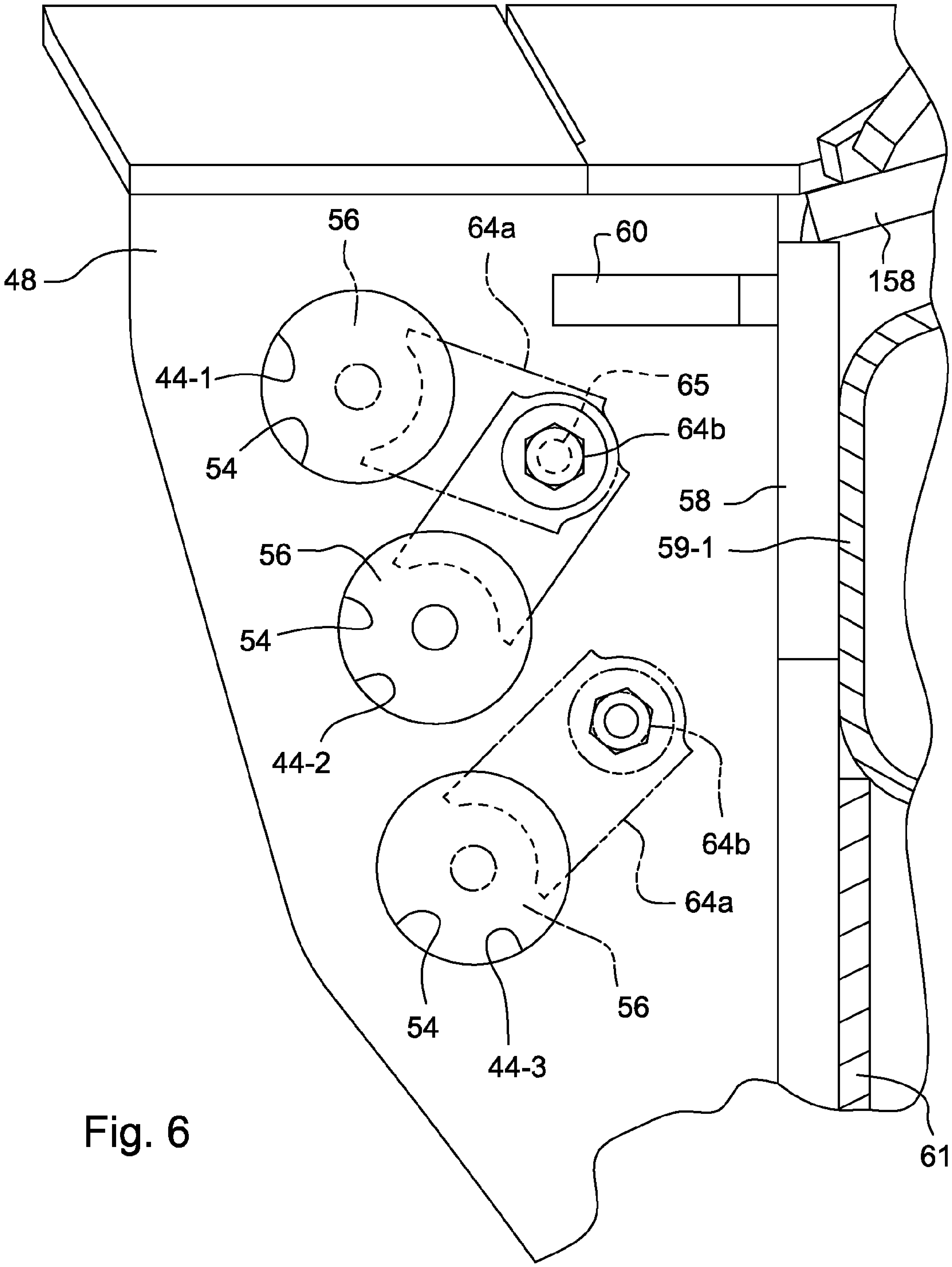

Fig. 6

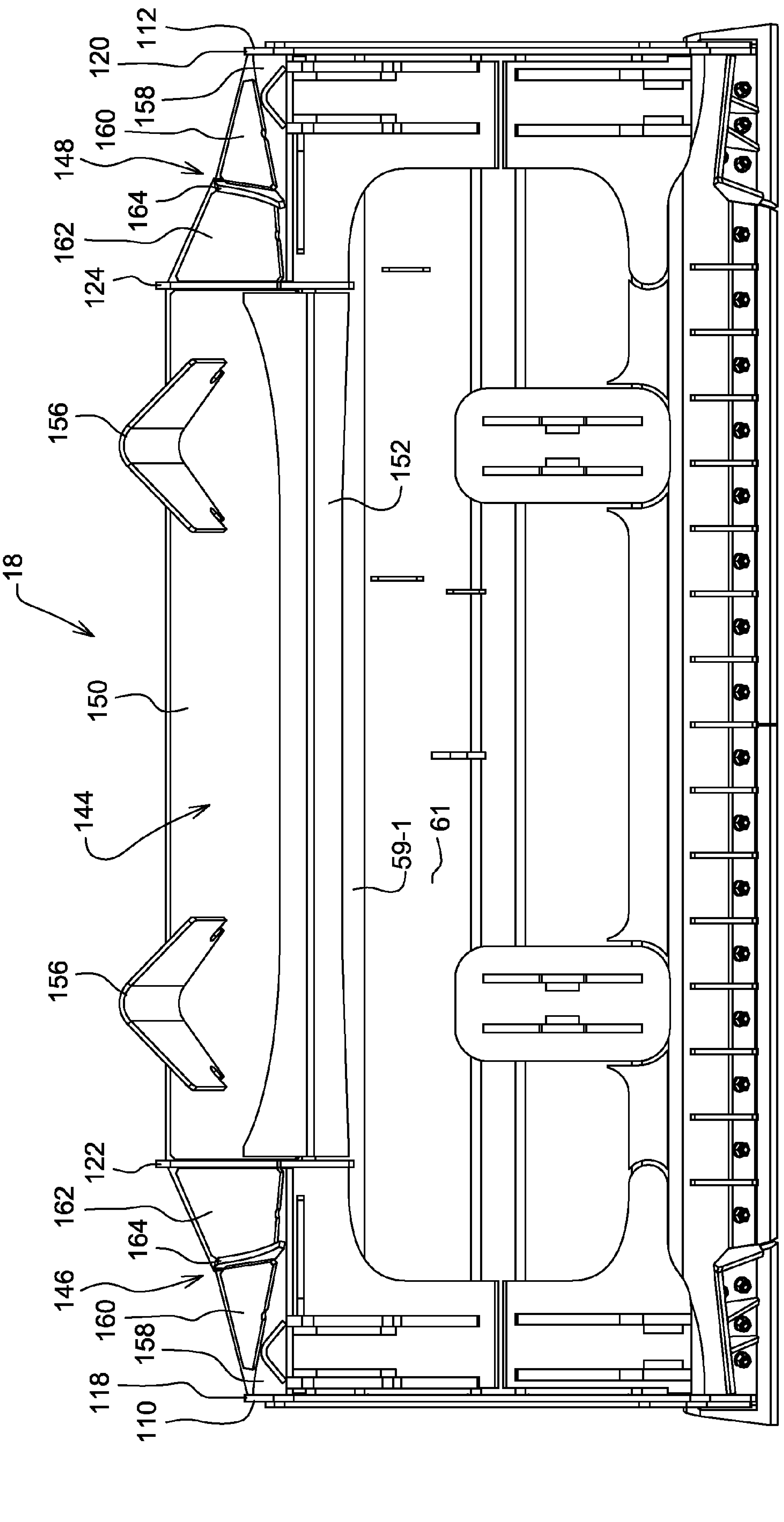
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Fig. 7

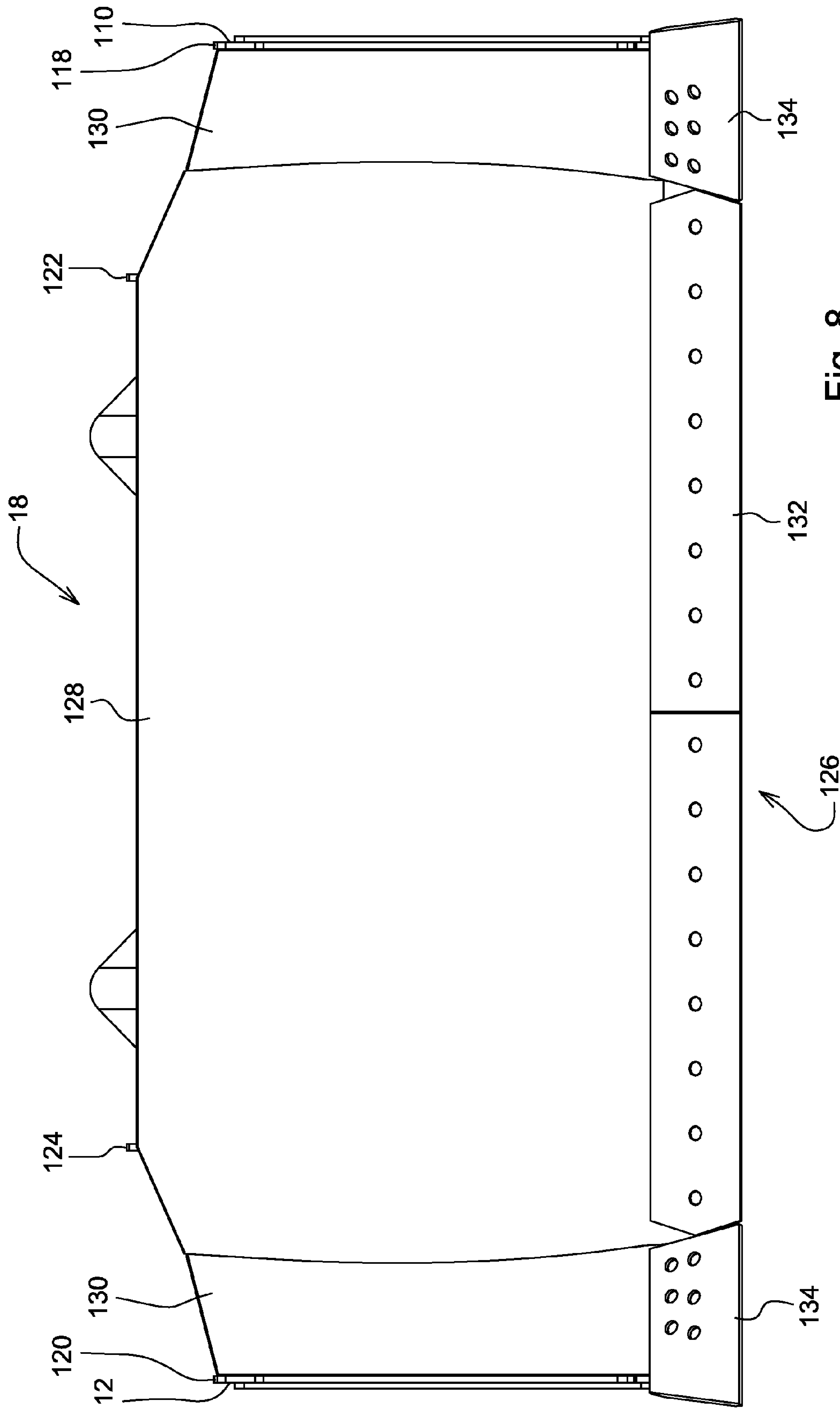

Fig. 8

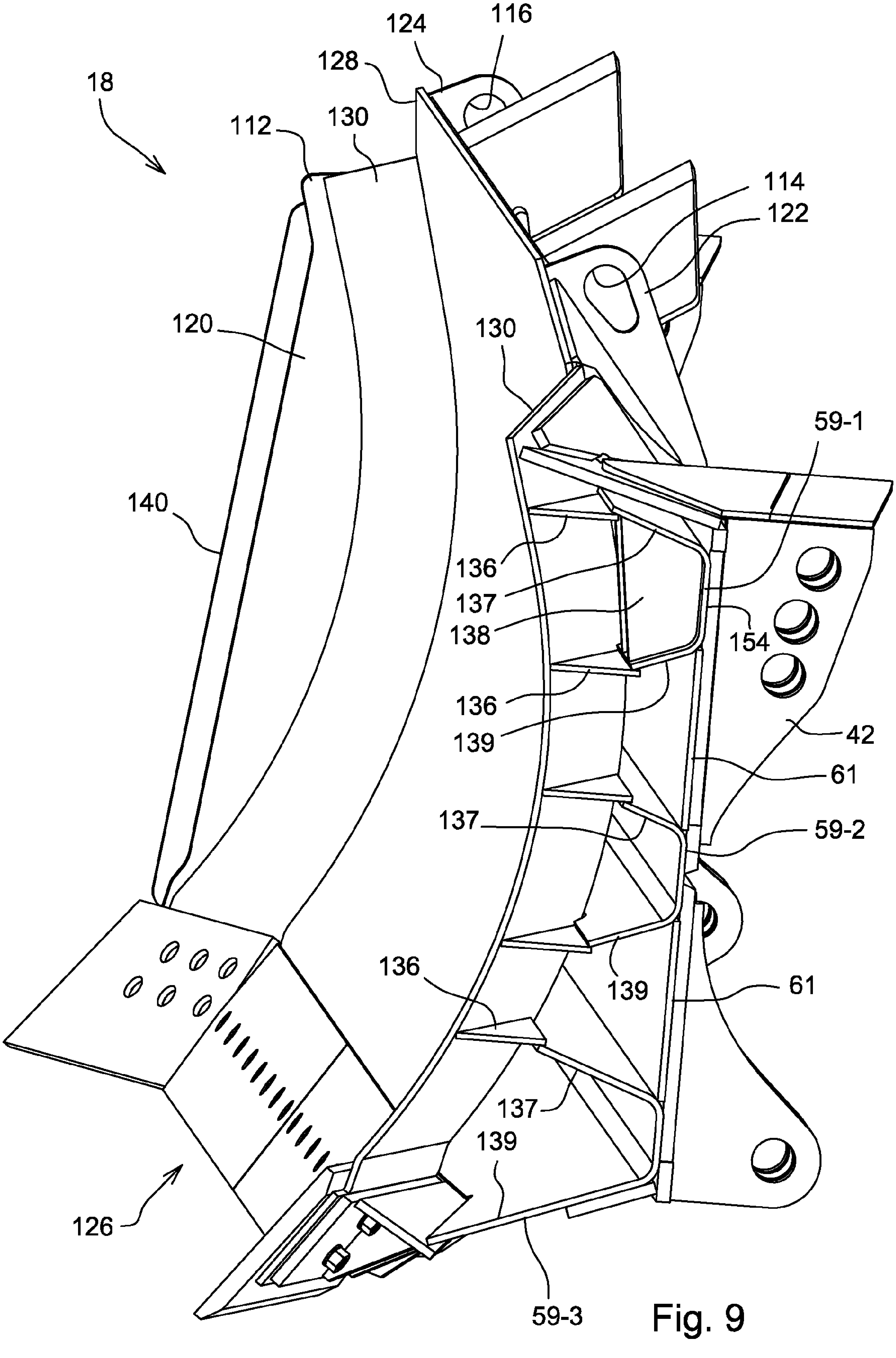
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Fig. 9

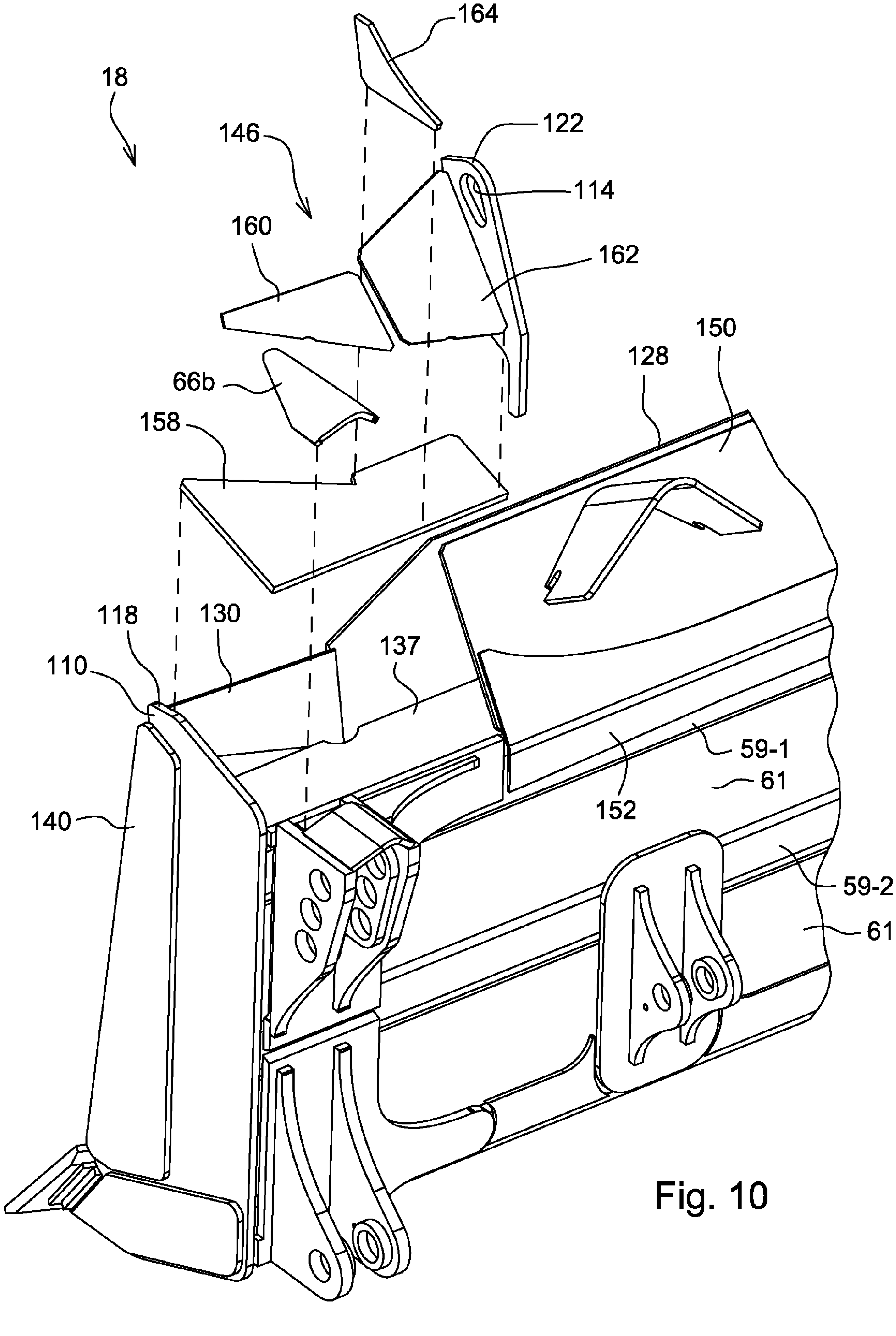
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Fig. 10

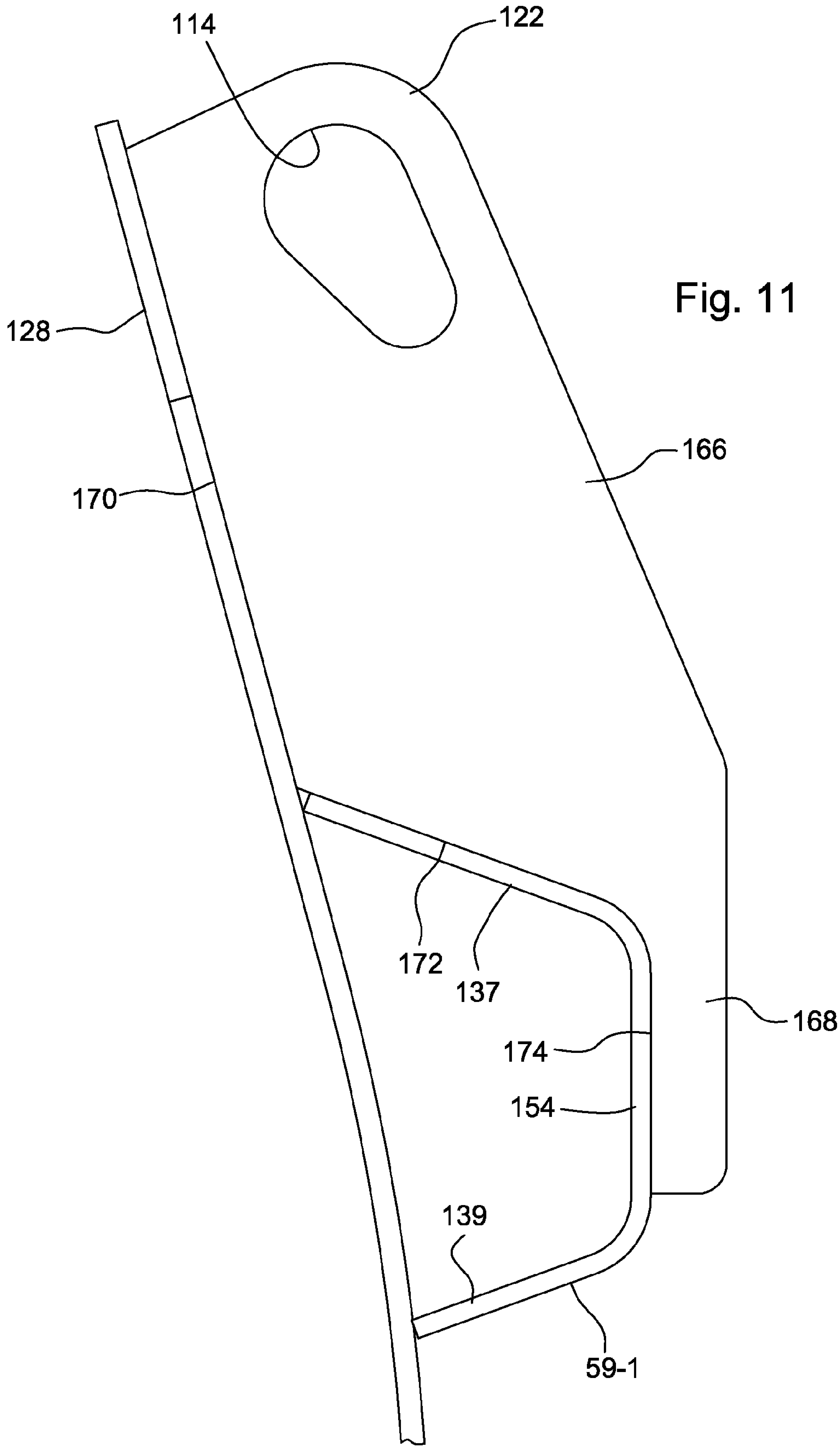

Fig. 11

BLADE APPARATUS WITH BLADE PITCH ADJUSTABILITY

FIELD OF THE DISCLOSURE

The present disclosure relates to adjustability of the pitch of a blade for a work vehicle.

BACKGROUND OF THE DISCLOSURE

There are prior art crawler dozers for use in heavy duty applications which have a base machine and a blade apparatus coupled to the base machine. The blade apparatus has a blade configured to push large quantities of soil, sand, rubble, or other material, earthen or otherwise, and a blade driver configured to interconnect the blade and the base machine.

The blade driver has a frame with a pair of push-beams positioned laterally outward from and pivotally coupled to the base machine. The blade is pivotally coupled to the push-beams. The blade driver also has a pitch link in the form of a turnbuckle pivotally coupled to one of the push-beams and the blade and a tilt link in the form of a hydraulic cylinder pivotally coupled to the other push-beam and the blade. The length of the pitch link is adjustable to adjust the pitch of the blade, and the length of the tilt link is adjustable to adjust the tilt or roll angle of the blade (i.e., the angle of the blade about a fore-aft axis of the dozer). When the pitch link is lengthened, a corresponding amount of tilt angle adjustability is lost since lengthening of the pitch link causes the rod of the tilt link to extend correspondingly.

One type of prior art blade driver has a link anchor on each of the two push-beams: one link anchor for anchoring a frame end of the pitch link and one link anchor for anchoring a frame end of the tilt link. Each such link anchor includes a plurality of mounting points (three) for the respective link, each mounting point having a pair of holes for receiving a pin coupled to the frame end of that link. The mounting points of the two anchors are arranged in pairs, one from the pitch link anchor and one from the tilt link anchor, such that each pair of mounting points corresponds to a respective pitch of the blade relative to the frame. The frame ends of the pitch and tilt links are thus coupleable to any one of the pairs of mounting points to establish the blade at the pitch corresponding to that pair of mounting points, without causing a loss of tilt angle adjustability. As is known in the prior art, dozer operators have complained about the limitations of the pitch adjustability of such an arrangement due to its coarse pitch resolution.

SUMMARY OF THE DISCLOSURE

According to an aspect of the present disclosure, there is provided a blade apparatus for a work vehicle. The blade apparatus comprises a frame, a blade pivotally coupled to the frame, first and second link anchors, and first and second links. Each of the first and second link anchors is mounted to the blade and comprises a plurality of mounting points. The mounting points of the first and second link anchors are arranged in pairs of mounting points, one from the first link anchor and one from the second link anchor, such that each pair of mounting points corresponds to a respective pitch of the blade relative to the frame.

The first and second links are pivotally coupled to the frame and pivotally coupled respectively to the mounting points of a selected one of the pairs of mounting points to establish the blade at the pitch corresponding to that pair of mounting points. The pitch of the blade can be adjusted by changing to

which pair of mounting points the first and second links are pivotally coupled respectively.

Mounting of the link anchors with multiple mounting points to the blade rather than the push-beams provides a number of benefits. It affords ergonomic pitch adjustment in a location less susceptible to accumulation of packed material, without a corresponding loss of tilt angle adjustability. Further, the anchors can be designed to position the mounting points so as to achieve a generally desired pitch resolution between the mounting points, such as a relatively fine pitch resolution as compared to the relatively coarse pitch resolution afforded by the afore-mentioned prior art link anchors mounted to the push-beams. Such frame-mounted link anchors are limited in pitch resolution by stress considerations.

The above and other features will become apparent from the following description and the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description of the drawing refers to the accompanying figures in which:

FIG. **1** is left side elevation view showing a work vehicle exemplarily in the form of a crawler dozer having a base machine (shown in simplified form) and a blade apparatus having an adjustable-pitch blade and a blade driver interconnecting the blade and the base machine;

FIG. **2** is a perspective view of the blade apparatus showing a pitch link (foreground) and a tilt link (background) pivotally coupled respectively to first and second push-beams and to selected mounting points of pitch link and tilt link anchors establishing the blade at a corresponding pitch relative to the frame;

FIG. **3** is a perspective view showing a blade end of the pitch link pivotally coupled to a middle mounting point of the pitch link anchor and a frame end of the pitch link pivotally coupled to a link anchor mounted on one of the push-beams;

FIG. **4** is a left side elevation view showing the plurality of mounting points of the pitch link anchor;

FIG. **5** is a sectional view taken along lines **5-5** of FIG. **3**;

FIG. **6** is a right side elevation view of the pitch link anchor;

FIG. **7** is a rear elevation view of the blade;

FIG. **8** is a front elevation view of the blade;

FIG. **9** is a perspective view of the blade, with portions broken away;

FIG. **10** is a partially exploded perspective view; and

FIG. **11** is a side elevation view showing a left lift eye plate mounted to a front wall and channel of the blade.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to FIG. **1**, there is shown a work vehicle **10** exemplarily configured as a crawler dozer (e.g., John Deere 850J crawler dozer). A blade apparatus **12** is included in and provided for use with the vehicle **10**. In the case of a crawler dozer, the base machine **14** of the dozer includes an operator station **15** and a tracked undercarriage **16**. From the operator station **15**, a human operator can control the base machine **14** and the blade apparatus **12** attached thereto.

The undercarriage **16** has left and right track assemblies positioned on laterally opposite sides of the base machine **14** for propulsion of the vehicle **10**, the left track assembly shown in simplified form at **17**. Each track assembly **17** has a rear drive sprocket **17***a* rotatably coupled to a main frame of the base machine **14** (the teeth of the sprocket **17***a* may be included in circumferential segments (e.g., five such segments) aligned circumferentially about the sprocket **17***a*), a front idler **17***b*, upper and lower rollers **17***c* rotatably coupled to a track frame **17***d* of the track assembly **17**, and a track **17***e* shown diagrammatically and trained about the drive sprocket **17***a*, the idler **17***b*, and the rollers **17***c*. The track **17***e* has a closed-loop chain, having two rows of interconnected links, and ground-engaging shoes mounted to the chain thereabout for engagement with the ground. A track chain tension adjuster is mounted to the track frame **17***d* and is coupled to the idler **17***b*, movable a distance fore-and-aft relative to the track frame **17***d*, to press the idler **17***b* against the chain to tension the track **17***e*. The undercarriage **16** may take any suitable form such as a conventional undercarriage.

The blade apparatus **12** includes a blade **18** and a blade driver **20**. The blade **18** is configured for moving large quantities of soil, sand, rubble, or other material, earthen or otherwise. The blade driver **20** interconnects the blade **18** and the base machine **14**.

Referring to FIG. **2**, the blade driver **20** includes a frame **21**. The frame **21** has a pair of push-beams **22**, a pair of cross-beams **24**, and a center joint **26**. Laterally outward ends of the cross-beams **24** are fixed respectively to the push-beams **22** through welding, and laterally inward ends of the cross-beams **24** are movably coupled to one another in, for example, a conventional manner using the center joint **26**.

Exemplarily, the center joint **26** includes a pin welded to a first plate welded to the end of the first cross-beams **24**, a spherical plain bearing (alternatively, a self-aligning ball bushing) receiving the pin such that the pin is movable linearly along its length within the bearing, and a center piece receiving the bearing and bolted to a second plate welded to the end of the second cross-beam **24** (welds are not shown in the drawings, but are to be understood).

The bearing may be retained in place in the center piece using two circlips, one on each side of the bearing. A link **30** pivotally coupled to a middle portion of the rear of the blade **18** and to a corner tang of the second plate interconnects the blade **18** and the cross-beams **24**. The center joint **26** is thus configured to allow rotational movement between the cross-beams **24** by virtue of the bearing and movement of the cross-beams **24** toward and away from one another by virtue of the capacity of the pin to move along its length relative to the bearing. It is to be understood that the center joint **26** may be configured in any suitable manner.

The push-beams **22** are pivotally coupled to and positioned laterally outward from the undercarriage **16** in, for example, a conventional manner using a pair of pivot couplings **19**. Exemplarily, each pivot coupling **31** may include a clamp **23** and a trunnion **28**. The clamp **23** may have a pair of caps **25**, with a first of the caps **25** fixed through welding to the rearward end of a push-beam **22**, and a half-moon bushing received in the first cap **25**. A ball **27** of the trunnion **28** may be received in the clamp **23** between the caps **25** with the half-moon bushing positioned between the ball **27** and the first cap **25**. The caps **25** may be bolted together and shimmed as needed to receive the ball **27**. A mounting plate **29** of the trunnion **28** may be bolted to the respective track frame (mounting plate bolts are shown in simplified form without threads, threads being understood). It is to be understood that the push-beams **22** may be pivotally coupled to the undercarriage **16** in any suitable manner.

The blade **18** is pivotally coupled to the frame **21** in, for example, a conventional manner using a pair of pivot couplings **31** of the blade driver **20**. Exemplarily, each pivot coupling **31** may include a pivot bracket **32** fixed to a forward end of a respective push-beam **22**, a clevis bracket **33** welded to an L-shaped mounting plate **34** welded to a lower portion of the rear of the blade **18** near a respective end of the blade **18**, and a lubricated pin **35** extending within holes of the brackets **32**, **33** and retained in place by a pin retainer **36**. A spherical plain bearing may be mounted within the pivot bracket **32** and retained therein using two circlips, one on either side of the bearing, and may receive the pin **35** therethrough. As an alternative to the coupling **31**, the pivot coupling may have a ball and a clamp clamping the ball, the clamp including a pair of caps, with a first of the caps fixed through welding to a forward end of a respective push-beam **22**, and a half-moon bushing received in the first cap. The ball may be received in the clamp between the caps with the half-moon bushing positioned between the ball and the first cap. The caps may be bolted together (e.g., using four bolts—two on top and two bottom) and shimmed as needed. The ball may have opposite end portions received in and welded to the holes of two ears of a clevis bracket mounted to the rear of the blade **18**. It is to be understood that the blade **18** may be pivotally coupled to the frame **21** in any suitable manner.

A pair of trunnion-mounted hydraulic lift cylinders **37**, one of which is shown in FIG. **1**, is pivotally coupled to the base machine **14** and to the blade **18** using pivot couplings in, for example, a conventional manner or any other suitable manner. Exemplarily, the cylinders **37** are mounted to either side of the base machine **14** and to the rear of the blade **18** using respective pivot couplings. The operator can raise and lower the blade **18** relative to the base machine **14** using the lift cylinders **32**.

The blade apparatus **12** further includes a first or pitch link **38** and a second or tilt link **39**, each having an adjustable length. Each link **38**, **39** is pivotally coupled to a respective push-beam **22** and to an upper portion of the rear of the blade **18** next to an end of the blade **18**. The pitch link **38** is, for example, a turnbuckle having externally threaded opposite ends and an internally threaded sleeve threaded thereto (the external threads of the turnbuckle ends shown diagrammatically and having a thread specification of, for example, M60×3, where the "60" and the "3" represent the major diameter and pitch, respectively, both in millimeters). The external threads of the turnbuckle ends may illustratively be partially exposed outside the turnbuckle sleeve, or, in other embodiments, may be completely hidden within the sleeve to minimize exposure to debris. Alternatively, the pitch link **38** may be a fixed-length link. The tilt link **39** is, for example, a hydraulic cylinder (the extend hose and the retract hose are not shown). As such, the length of the pitch link **38** can be adjusted mechanically to change the pitch of the blade **18** relative to the frame **22**, and the length of the tilt link **39** can be adjusted hydraulically, such as by the operator from the operator station **15**, to change the tilt angle of the blade **18** relative to a central fore-aft axis **80** of the vehicle **10**.

Each link **38**, **39** is pivotally coupled to a respective push-beam **22** in, for example, a conventional manner using a link anchor **70**. Exemplarily, each link anchor **70** may be mounted on the respective push-beam **22** and may provide a single mounting point for the frame end **40** of the respective link **38**, **39**. Each link anchor **70** may include a clevis bracket **72**, welded to a mounting plate **74** welded to the top of the push-beam **22** and a lubricated pin **76**. The pin **76** extends within a pair of holes of the bracket **72** and through a hole of the frame end **40** of the respective link **38**, **39** and a bushing positioned on either side of that link **38**, **39** and is retained in place by a pin retainer **78**. It is to be understood that the links **38**, **39** may be pivotally coupled to a respective push-beam **22** in any suitable manner.

The pitch and tilt links **38**, **39** are pivotally coupled respectively to a first or pitch link anchor **42** and a second or tilt link anchor **43**. The anchors **42**, **43** are mounted to the upper portion of the rear of the blade **18** next to the ends of the blade **18**.

Each anchor **42**, **43** has a plurality of mounting points **44**, such as three mounting points **44-1**, **44-2**, and **44-3**. The mounting points **44** of the anchors **42**, **43** are arranged in pairs of mounting points, one from the pitch link anchor **42** and one from the tilt link anchor **43**, such that each pair of mounting points corresponds to a respective pitch of the blade **18** relative to the frame **21**.

As such, the frame ends **40** of the pitch and tilt links **38**, **39** are pivotally coupled to the frame **21** and the blade ends **41** of the pitch and tilt links **38**, **39** are pivotally coupled respectively to the mounting points of a selected one of the pairs of mounting points **44-1**, **44-2**, or **44-3** to establish the blade **18** at the pitch corresponding to that pair of mounting points **44-1**, **44-2**, or **44-3**. The pitch of the blade **18** can be adjusted by changing to which pair of mounting points **44-1**, **44-2**, or **44-3** the links **38**, **39** are pivotally coupled respectively.

The top, middle, and bottom pairs of mounting points **44-1**, **44-2**, **44-3** are thus used to establish different pitches of the blade **18**. For example, the top, middle, and bottom pairs of mounting points **44-1**, **44-2**, **44-3** provide a pitch of 53°, 55.3°, and 58° for the blade **18** (pitch shown as angle θ in FIG. **1**), this measure of pitch illustrated between the cutting edge of the blade and a horizontal surface (e.g., the ground). As alluded to above, the pitch link **38** may have a fixed length or may have an adjustable length (as with a turnbuckle). Length adjustability of the pitch link **38** may be useful to compensate for manufacturing tolerance stack-up (e.g., variation in cylinder stroke and close lengths in the case of a cylinder for tilt cylinder **39**) so as to fine-tune the system, and may be useful to provide even more fine pitch adjustment of the blade **18**.

Mounting of the link anchors **42**, **43** with multiple mounting points to the blade **18** rather than the push-beams **22** provides a number of benefits. It affords ergonomic pitch adjustment of the blade **18** in a location less susceptible to accumulation of packed material, without a corresponding loss of tilt angle adjustability.

Further, the anchors **42**, **43** can be designed to achieve a generally desired pitch resolution between the mounting points **44-1**, **44-2**, **43**, such pitch resolution limited by suitable spacing between the mounting points **44-1**, **44-2**, **44-3** for stress management of the anchor. For example, the anchors **42**, **43** may be designed to provide a relatively fine pitch resolution (e.g., about 2.5° between adjacent pitch positions), as compared to the relatively coarse pitch resolution (e.g., about 5° between adjacent pitch positions) afforded by the afore-mentioned prior art link anchors mounted to the frame push-beams.

Such frame-mounted link anchors are limited in pitch resolution by stress considerations. More particularly, stress considerations limit their height, causing the mounting points to be arranged relative to one another more horizontally than vertically resulting in a more coarse pitch resolution, in contrast to the mounting points **44** of the link anchors **42**, **43** which are arranged relative to one another more vertically than horizontally affording a more fine pitch resolution.

Since the anchors **42**, **43** are mounted to the blade **18** rather than the push-beams **22**, a designer has more design flexibility with respect to the pitch resolution built into the system **12**. As mentioned above, the anchors **42**, **43** can be designed to have a relatively fine pitch resolution. It is to be appreciated that in other examples the designer could, if desired, provide the anchors **42**, **43** with a more coarse pitch resolution.

The pitch resolution is affected by the positioning of the mounting points **44** relative to the link anchors **70** and the blade **18**. For sake of description, the link anchor **70** to which the pitch link **42** is coupled may be referred to as the third link anchor **70**, and the link anchor **70** to which the tilt link **43** is coupled may be referred to as the fourth link anchor **70**. As such, the mounting points **44** of the link anchor **42** are non-equidistant from the third link anchor **70**, and the mounting points **44** of the link anchor **43** are non-equidistant from the fourth link anchor **70**. The top mounting points **44-1** are positioned farther away from third and fourth link anchors **70**, respectively, than the middle mounting points **44-2** such that the pitch angle corresponding to the top mounting points **44-1** is greater than the pitch angle corresponding to the middle mounting points **44-2**, and the middle mounting points **44-2** are positioned farther away from the third and fourth link anchors **70**, respectively, than the lower mounting points **44-3** such that the pitch angle corresponding to the middle mounting points **44-2** is greater than the pitch angle corresponding to the bottom mounting points **44-3**.

The mounting points **44** of each anchor **42**, **43** are also non-equidistant from the blade **18**. The top mounting points **44-1** are positioned farther away from the blade **18** than the middle mounting points **44-2**, and the middle mounting points **44-2** are positioned farther away from the blade **18** than the bottom mounting points **44-3**. The positioning of the mounting points **44** relative to the respective link anchor **70** and the blade **18** thus affects the pitch resolution between the mounting points.

Referring to FIGS. **3-5**, each of the anchors **42**, **43** includes a clevis bracket **47** and a pin **56**. The clevis bracket **47** has a first ear **48** and a second ear **48**. The ears **48** are mounted to the rear of the blade **18** via an L-shaped mounting plate **58**. Each mounting point **44** of each anchor **42**, **43** has a pair of holes **54** (see FIG. **5**). The first and second ears **48** of each clevis bracket **47** include respectively the first and second holes **54** of each mounting point **44** of that anchor **42**, **43**.

The holes **54** of each mounting point **44** are configured to receive the pin **56** about which the blade end **41** of the respective link **38**, **39** can pivot. To establish a particular pitch for the blade **18**, the pin **56** at each anchor **42**, **43** is inserted into the holes **54** of the respective mounting point **44-1**, **44-2**, or **44-3** and fastened in place to the clevis bracket **47**. To change the pitch of the blade **18**, the pin at each anchor **42**, **43** is unfastened and removed from the holes **54** of the current mounting point and inserted into the holes **54** of the new mounting point and re-fastened in place.

Referring to FIG. **5**, each ear **48** has a main side plate **48*a*** and a second plate **48*b*** welded to a face of the side plate **48*a***. The plates **48*a***, **48*b*** cooperate to provide the holes **54** of the ear **48**. The side plates **48*a*** are welded to the mounting plate **58** so as to extend rearwardly therefrom, the mounting plate **58** being welded to the rear of the blade **18**, in particular to generally C-shaped top and middle channels **59-1**, **59-2** and a flat upper rear plate **61** extending therebetween and welded thereto The mounting plate **58** may have a weld groove formed in a laterally outward edge of the plate **58** to receive a weld therein to facilitate welding together of the plate **58**, the side plate **48*a*** of the laterally outward ear **48**, the channels **59-1**, **59-2**, and the plate **61**. The rear of the blade **18** further includes a generally C-shaped bottom channel **59-3** and flat lower rear plate **61** extending between and welded to the channels **59-2** and **59-3**. The mounting plate **34** is welded to the channels **59-2**, **59-3** and the lower rear plate **61**.

A gusset **60** reinforces the clevis bracket **47** of each anchor **42**, **43** laterally inward thereof. The gusset **60** is welded to the side plate **48*a*** of the laterally inward ear **48** of the anchor **42**, **43** and to the mounting plate **58**.

The blade end **41** of each link **38**, **39** is received between the ears **48** of the respective anchor **42**, **43**. A bushing **62**, one of which is shown, is positioned on either side of the blade end **41** between the blade end **41** and an ear **48** to limit play between the ears **48**. The pin **56** extends in the holes **54** through the bushings **62** and the blade end **41**.

Referring to FIGS. **5** and **6**, a pin retainer **64** retains the pin **56** in place in the holes **54** of the selected mounting point **44**. The pin retainer **64** includes a retainer plate **64***a* and a fastener **64***b* securing the plate **64***a* to the side plate **48***a* of the laterally inward ear **48**. The plate **64***a* is received in an annular groove formed, in the pin **56**. The fastener **64***b* is threaded selectively into one of two threaded retainer holes **65** (threads not shown) formed in the laterally inward ear **48**. Exemplarily, each hole **65** may be a through-hole in just the side plate **48***a* of that ear **48** or a through-hole through both the side plate **48***a* and plate **48***b* of that ear **48**. The fastener **64***a* is screwed into the top retainer hole **65** to secure the pin **56** in the holes **54** of the middle mounting point **44-2** (FIG. **5**), and is screwed into the bottom retainer hole **65** to secure the pin **56** in the holes **54** of either the top or bottom mounting points **44-1**, **44-3** (FIG. **6**).

Referring back to FIG. **5**, each anchor **42**, **43** further includes a cap **66** fixed to the tops of the ears **48** so as to interconnect the tops of those ears **48**. Exemplarily, the cap **66** includes a bent, generally rectangular first cap plate **66***a* and a bent, generally triangular second cap plate **66***b*. The first cap plate **66***a* is welded to the tops of the side plates **48***a*. The second cap plate **66***b* is positioned between the first cap plate **66***a* and the blade **18** and is welded to the tops of the side plates **48***a*, the top of the blade **18**, and the first cap plate **66***a*. A weld groove is formed in an edge of the second cap plate **66***b* for welding the first and second cap plates **66***a*, **66***b* to one another. Alternatively, the cap **66** may be a one-piece structure.

Referring to FIGS. **2** and **7**, the blade **18** has a first or left end **110**, a second or right end **112**, a first or left blade lift eye **114**, and a second or right blade lift eye **116**. The left and right ends **110**, **112** are longitudinally opposite to one another. A hoist can be coupled to each of the left and right blade lift eyes **114**, **116** to lift the blade **18**.

The left blade lift eye **114** is positioned closer to the left end **110** than the right end **112** atop the blade **18**, and the right blade lift eye **116** is positioned closer to the right end **112** than the left end **110** atop the blade **18**. The left blade lift eye **114** is inboard of the left end **110**, and the right blade lift eye **116** is inboard of the right end **112**. Each blade lift eye **114**, **116** is thus positioned in a relatively damage-free area such that the blade lift eye **114**, **116** is less susceptible to damage than if it were at the respective damage-prone end **110**, **112** of the blade **18**. Further, the left and right ends **110**, **112** of the blade **18** are lower than the left and right blade lift eyes **114**, **116**, respectively, enhancing operator visibility over the blade ends **110**, **112** from the operator's station **15**. In addition, although the blade **18** is not configured specifically for mounting of blade control towers near its ends (i.e., it does not include a bolting pattern for mounting of the towers), it is understood that, if so desired, a blade could be configured to have appropriate tower mounts for mounting a blade control tower near each end **110**, **112**, outboard of the lift eyes **114**, **116**, such that an inverted Y-shaped hoist may be coupled to the lift eyes **114**, **116** without requiring prior removal of the towers from such blade.

The left blade lift eye **114** is included in a first or left lift eye plate **122** of the blade **18**, and the right blade lift eye **116** is included in a second or right lift eye plate **124**. The left blade lift eye plate **122** is spaced apart from and inboard of a left end-cap plate **118** positioned at the left end **110**. The left lift eye plate **122** is inboard of the pitch link anchor **42**, the left gusset **60** reinforcing the pitch link anchor **42**, and the mounting plate **58** mounted to the rear of the blade **18** and to which the pitch link anchor **42** and the left gusset **60** are mounted. The right lift eye plate **124** is spaced apart from and inboard of a right end-cap plate **120** positioned at the right end **112**. The right lift eye plate **124** is inboard of the tilt link anchor **43**, the right gusset **60** reinforcing the tilt link anchor **43**, and the mounting plate **58** mounted to the rear of the blade **18** and to which the tilt link anchor **43** and the right gusset **60** are mounted.

Referring to FIG. **8**, the blade **18** includes a working, front wall **126** configured to perform the work of the blade **18**. The front wall **126** includes a main work plate **128**, two side work plates **130** flanking the main work plate **128** and welded thereto, a central cutting edge **132** bolted to a bottom portion of the main work plate **128**, and two side cutting edges **134** bolted to respective bottom portions of the side plates **130**.

Referring to FIG. **9**, the channels **59-1**, **59-2**, **59-3** are welded to the rear of the main work plate **128**. To interconnect the channels **59-1**, **59-2**, **59-3** and the side plates **130** so as to reinforce the side plates **130**, at each end region of the channels **59-1**, **59-2**, **59-3**, gussets **136** are welded to the top and bottom walls **137**, **139** of the channels **59-1**, **59-2**, **59-3**. A pair of gussets **138** is located within the channel **59-1** at the end regions thereof for internal reinforcement of that channel **59-1**.

The end-cap plates **118**, **120** are fixed respectively at the ends **110**, **112** of the blade **18**, as shown, for example, with respect to the left end-cap plate **118** in FIG. **2**. The end-cap plates **118**, **120** are welded respectively to the ends of the channels **59-1**, **59-2**, **59-3**, the ends of the plates **61**, the gussets **136**, and the side plates **130**. The end-cap plates **118**, **120** thus cover respectively the ends of the channels **59-1**, **59-2**, **59-3**. Each end **110**, **112** may further include plates **140**, **142** welded to the respective end-cap plate **118**, **120**, strengthening the respective end **110**, **112** and providing some wear resistance, as shown, for example, with respect to the left end **110** in FIG. **2**.

Referring back to FIG. **7**, rearward of the front wall **126**, an upper region of the blade **18** includes a central reinforcement structure **144** positioned between the left and right blade lift eye plates **122**, **124**, a left reinforcement structure **146** positioned between the left end-cap plate **118** and the left blade lift eye plate **114**, and a right reinforcement structure **148** positioned between the right end-cap plate **120** and the right blade lift eye plate **116**. The central and left reinforcement structures **144**, **146** are welded or otherwise coupled to opposite sides of the left blade lift eye plate **122**, and the central and right reinforcement structures **144**, **148** are welded or otherwise coupled to opposite sides of the right blade lift eye plate **124**.

The central reinforcement structure **144** includes a central plate **150** and an angle bar **152**. The central plate **150** is welded to the rear of the main work plate **128** and a top wall **137** of the top channel **59-1**. The angle bar **152** is welded to the central plate **150** and a rear wall **154** of the top channel **59-1**. A pair of inverted V-shaped debris guards **156** may be mounted to the central plate **150** for diverting debris that may flow over the top of the blade **18** away from the lift cylinders **37**.

Referring to FIGS. **7** and **10**, each of the left and right reinforcement structures **146**, **148** includes a base plate **158**, a generally triangular laterally outward plate **160**, a generally trapezoidal laterally inward plate **162**, and a generally triangular laterally intermediate plate **164** laterally between the laterally outward plate **160** and the laterally inward plate **162**. The base plate **158** is welded to the respective end-cap plate **118**, **120**, the main work plate **128**, the respective side work plate **130**, and a top edge of the respective mounting plate **58**. The intermediate plate **164** is mounted on edge to the base plate **158** so as to be upright and is welded to the base plate **158**, a rear of the main work plate **128**, and a laterally inward edge of the respective side work plate **130**. The outward plate

160 leans against and is welded to a rear of the respective side work plate **130** and the intermediate plate **164**. The inward plate **162** leans against and is welded to a rear of the main work plate **128** and is positioned between and welded to the intermediate plate **164** and the respective blade lift eye plate **122**, **124**. The illustrated notches formed in the bottom edges of the plates **160**, **162** and in the top wall **137** of the top channel **59-1** are provided for manufacturing purposes, to help identify which direction the component is to be oriented.

Referring to FIG. **11**, as shown, for example, with respect to the left blade lift plate **122**, each of the left and right blade lift eye plates **122**, **124** includes a body **166** and a tail **168** depending from the body **166** behind the rear wall **154** of the top channel **59-1**, the body **166** and the tail **168** cooperating such that the respective plate **122**, **124** is a one-piece construction. The body **166** of the left blade lift eye plate **122** includes the left blade lift eye **114**, and the body **166** of the right blade lift eye plate **124** includes the right blade lift eye **116**.

Each of the left and right blade lift eye plates **122**, **124** is mounted on edge to the top channel **59-1** and the front wall **126**. A front peripheral edge **170** of the body **166** is welded or otherwise mounted to the rear of the main work plate **128**. A bottom peripheral edge **172** of the body **166** is welded or otherwise mounted to a top wall **137** of the top channel **59-1**. A front peripheral edge **174** of the tail **168** is welded or otherwise mounted to a rear wall **154** of the top channel **59-1**. The body **166** is welded to the rear of the main work plate **128**, the top wall **137** of the top channel **59-1**, the respective inward plate **162**, the central plate **150**, and the angle bar **152** such that the body **166** is positioned laterally between the respective inward plate **162** and the central plate **150** and laterally between the respective inward plate **162** and the angle bar **152**. The tail **168** is welded to the rear wall **154** of the top channel **59-1**, the respective mounting plate **58**, and the angle bar **152** such that the tail **168** is positioned laterally between the respective mounting plate **58** and the angle bar **152**.

It is to be understood that, for purposes of the pitch and tilt link anchors **42**, **43**, the blade lift eyes **114**, **116** may be positioned at the ends or inboard of the ends **110**, **112**. It is to be understood that, for purposes of the blade lift eyes **114**, **116**, the pitch and tilt link anchors **42**, **43** may have any number of mounting points (e.g., one, two, three, or more).

The blade apparatus **12** may be made of conventional or other suitable materials. Exemplarily, the cutting edges **132**, **134** may be made of hardened, wear-resistant steel. Further exemplarily, the structural components of the blade **18** and blade driver **20**, as well as other components welded to the blade or blade driver **20** (e.g., ears **48**, caps **66**, mounting plates **58**, gussets **60**), may be made of high-strength, low alloy steel (e.g., plates **128**, **130** having 100,000 psi yield strength and remainder having 50,000 psi yield strength).

While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such illustration and description is to be considered as exemplary and not restrictive in character, it being understood that illustrative embodiments have been shown and described and that all changes and modifications that come within the spirit of the disclosure are desired to be protected. It will be noted that alternative embodiments of the present disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations that incorporate one or more of the features of the present disclosure and fall within the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A blade apparatus for a work vehicle, comprising:

a frame,

a blade pivotally coupled to the frame,

a first link anchor and a second link anchor, each of the first and second link anchors mounted to the blade and comprising a plurality of mounting points, the mounting points of the first and second link anchors arranged in pairs of mounting points, one from the first link anchor and one from the second link anchor, such that each pair of mounting points corresponds to a respective pitch of the blade relative to the frame, and

a first link and a second link, at least one of the first and second links having an adjustable length, the first and second links pivotally coupled to the frame and pivotally coupled respectively to the mounting points of a selected one of the pairs of mounting points to establish the blade at the pitch corresponding to that pair of mounting points, the pitch of the blade adjustable by changing to which pair of mounting points the first and second links are pivotally coupled respectively, wherein each mounting point comprises a first hole and a second hole, each of the first and second link anchors comprises a first ear and a second ear, the first and second ears of each of the first and second link anchors comprise respectively the first and second holes of each mounting point of that link anchor, each of the first and second link anchors comprises a top mounting point, a middle mounting point, a bottom mounting point, a pin, and a pin retainer configured to retain the pin in the first and second holes of a selected one of those mounting points, the pin retainer comprises a retainer plate engaging the pin and a fastener securing the retainer plate to the first ear, and the fastener is coupled to a top retainer hole of the first ear to secure the pin in the first and second holes of the middle mounting point and is coupled to a bottom retainer hole of the first ear to secure the pin in the first and second holes of either the top or bottom mounting points.

2. The blade apparatus of claim **1**, wherein the mounting points of each of the first and second link anchors are arranged relative to one another more vertically than horizontally.

3. The blade apparatus of claim **1**, wherein the first link is pivotally coupled to the frame at a third link anchor, the second link is pivotally coupled to the frame at a fourth link anchor, the mounting points of the first link anchor are non-equidistant from the third link anchor, and the mounting points of the second link anchor are non-equidistant from the fourth link anchor.

4. The blade apparatus of claim **3**, wherein, with respect to each of the first and second link anchors, the mounting points are non-equidistant from the blade.

5. The blade apparatus of claim **4**, wherein the top mounting points are positioned farther away from the blade and the third and fourth link anchors, respectively, than the middle mounting points, and the middle mounting points are positioned farther away from the blade and the third and fourth link anchors, respectively, than the bottom mounting points.

6. The blade apparatus of claim **1**, wherein each of the first and second link anchors comprises a cap fixed to the tops of the first and second ears of that link anchor so as to interconnect such tops.

7. The blade apparatus of claim **6**, wherein each cap is fixed to the top of the blade.

8. The blade apparatus of claim **1**, wherein each of the first and second link anchors comprises a gusset positioned laterally inwardly from the first and second ears and reinforcing the first ear.

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